

DMIP 2 Modeling Instructions For Oklahoma Basins

A. Overview

These experiments are designed to address the science questions proposed in the DMIP 2 Science Plan for the Oklahoma region. Participants are referred to the Science Plan for background information.

A.1 Mandatory and Optional Forcings

We require that all groups participating in the Oklahoma experiments use the supplied NEXRAD radar precipitation estimates. These are produced at the NWS Arkansas-Red Basin River Forecast Center for operational river forecasting. They include quality control review by Hydrometeorological Analysis and Support (HAS) experts at the River Forecast Center. These data must be used to generate the simulations described below in the specific instructions.

We suggest two sources of data to estimate potential evaporation. First, we provide the climatological monthly mean Free Water Surface Evaporation estimates made available in DMIP 1. Second, we also provide a link to the North American Regional Reanalysis (NARR) web site. DMIP 2 participants are free to extract the needed variables from the NARR data to compute estimates of potential evaporation forcing for their models.

A.2 Relation to DMIP 1 modeling instructions.

The instructions for comparing lumped with distributed models are basically the same as those we specified in DMIP 1. Since we have located additional gauged sites, we have removed the use of ungauged points in all basins except for the Blue River, which has no gauged interior points. We have also decided to use the USGS gauge on the Illinois River at Siloam Springs, AR, as a calibration gauge rather than the gauge at Watts, OK.

A.3 Note to Returning DMIP 1 Participants

In DMIP 1, we forced the models with an archive of the operational NEXRAD-based gridded precipitation estimates starting in 1993. This archive of operational data was subject to time-varying biases due in part to changes and enhancements in the processing algorithms, especially before 1996. (see: “Evaluating NEXRAD Multisensor Precipitation Estimates for Operational Hydrologic Forecasting” by Young et al., July, 2000, Journal of Hydrometeorology, Vol. 1, 241-254).

In DMIP 2 we would like to avoid these bias-prone data and use a later record of the operational archive of NEXRAD radar precipitation estimates. This period will begin on October 1, 1996 and extend into 2006. DMIP 2 participants must use these data as the primary forcing. For DMIP 2 we are asking each participant to submit both calibrated and uncalibrated simulations based on data from this period (the new calibration period is October 1, 1996 to September 30, 2002). However, we also wish to understand the

impacts of using different calibration periods. Therefore, we ask that returning participants from DMIP 1 also submit model simulations using parameters from their DMIP 1 calibrations. After these simulations are generated, the returning DMIP 1 participants are asked to re-calibrate (if necessary) their model parameters using the new calibration period.

A.4 Model Warm-up and Calibration

Participants should use the period October 1, 1995 to September 30, 1996 as a ‘warm-up’ period for their models prior to the calibration period. However, no adjustments to model states are allowed during this period.

Calibration will be carried out by comparing observed and simulated streamflow only at the five designated basin outlets (indicated in brown in Section B.1 below) during the calibration period. Even though observed streamflow data may be readily available at some interior nested locations, modelers are asked to ignore these data in the calibration process. One emphasis of DMIP is to assess how well distributed models predict streamflow at interior locations, especially at ungauged sites. One reason we don’t allow the use of interior point data for calibration in these comparisons is that many forecast basins around the country do not have interior point data available. We recognize that where available, these data may be useful in improving outlet simulations. Therefore, we do not discourage independent investigation into this issue apart from these formal comparisons.

Modelers will be asked to generate and submit to HL two basic types of simulations at specified points. The first type of simulation will be generated using initial or uncalibrated values of the hydrologic model parameters (and any hydraulic routing parameters). This test is to determine how well so-called "physically based" models perform with parameters derived from physical data. Participants will submit their uncalibrated simulations from both the calibration and verification periods. The second type of simulation is generated after hydrologic and hydraulic model parameters are calibrated at the designated basin outlets. This simulation is meant to show how much calibration is required and what improvement in simulation accuracy is gained. Participants will submit their simulations (using calibrated parameters) for both the calibration and verification periods.

During the same model runs to generate the basin outlet hydrographs (with both outlet calibrated and uncalibrated parameters), participants will also simultaneously generate simulations at interior points. In all but the Blue River basin, we have located interior points where observed streamflow data are available. As stated above, there should be no calibration using these interior observed data. These "blind" simulations will be used to assess how well interior processes can be simulated when calibration was performed using only basin outlet data.

For the Blue River basin, we specify the location of two ungauged points along the main channel or a major tributary of the basin. These simulations will be analyzed by HL personnel to assess the variability of simulations from the various distributed models. See Table 1 and Figure 1 below for a more precise description of the interior point locations.

Modelers will thus have to discretize their models in order to generate the interior hydrographs at the specified locations.

A.5 Stream Gauges in Oklahoma Basins

The Illinois River flowing through Arkansas and Oklahoma presents a good opportunity for participants to test their models on 3 different scales of basins, each having observed streamflow data at interior locations. The smallest basin, Baron Fork at Eldon, OK. (see also:

<http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/eldon.html>) has a drainage area of 795 sq. km. (307 sq. miles) with an interior gauge on Peacheater Creek at Christie, OK. Note that for DMIP 2, we have located another gauge in the Baron Fork basin at Dutch Mills, OK. (see:

<http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/dutchmills.html>)

Next to the Baron Fork basin is the Illinois River above the gauge at Watts, OK. This basin has a drainage area of 1645 sq. km (635 sq. miles) and includes the interior gauge on the Illinois River at Savoy, Arkansas. For DMIP 2, we have located three additional interior gauges in the Watts basin: Osage Creek near Cave Springs and Osage Creek near Elm Springs and the Illinois River South of Siloam Springs. The Illinois River at Watts, OK, is nested within the largest basin, the Illinois River above Tahlequah, OK, having a drainage area of 2484 sq. km (959 square miles). The Tahlequah basin also includes an interior gauge on Flint Creek at Kansas, OK

(<http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/kansas.html>)

and two new gauges for DMIP 2 located on Flint Creek at Springtown, AR, and Sager Creek near West Siloam Springs, OK.

(<http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/springtown.html>)

Thus, the Illinois River above Tahlequah, OK, contains eight interior gauge locations.

For DMIP 2 we have located two interior gauges in the Elk River basin. These are located on Big Sugar Creek near Powell, MO and on Indian Creek near Lanagan, MO.

The Blue River basin above the gauge in Blue, Oklahoma, has no interior gauge locations.

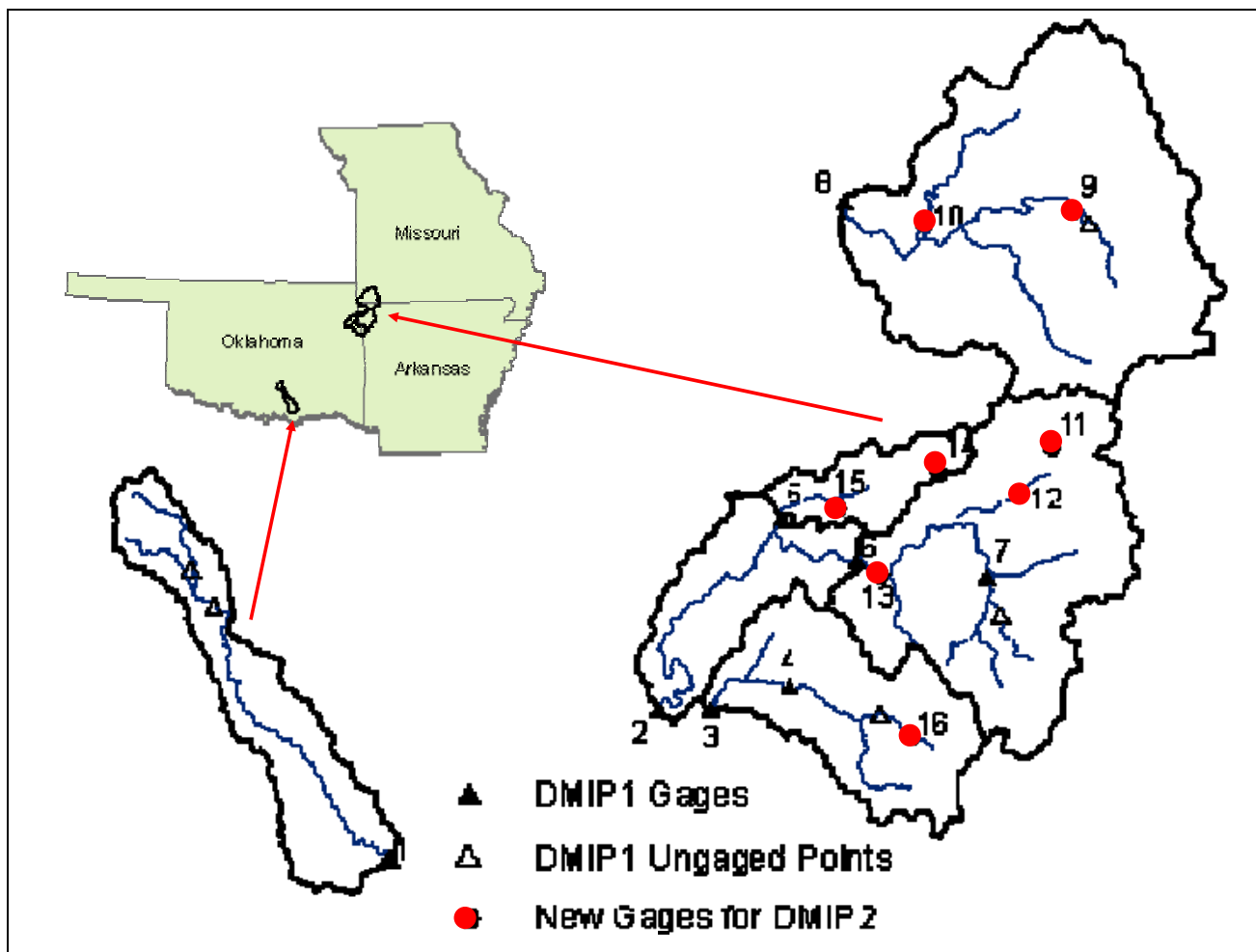


Figure 1. Location of DMIP test basins and interior computational points in the Oklahoma, Missouri, and Arkansas area. Note that additional gauges have been located for DMIP 2

Table 1. Data for USGS Stream Gauges in the Oklahoma Region. Note that we have located additional gauges that were not used in DMIP 1. These are gauges 9-16 shaded in yellow.

No	USGS No	Name	Latitude (degrees)	Longitude (degrees)	Area(km2)
1	7332500	Blue R. nr Blue, OK	33.99694	-96.24803	1233
2	7196500	Illinois River near Tahlequah OK	35.92286889	-94.9235658	2484
3	7197000	Baron Fork at Eldon OK	35.92120028	-94.8385633	795
4	7196973	Peacheater Creek at Christie OK	35.95480806	-94.6963369	65
5	7196000	Flint Creek near Kansas OK	36.1864725	-94.7068914	285
6	7195500	Illinois River near Watts OK	36.13008	-94.57216	1645
7	7194800	Illinois River at Savoy AR	36.10313567	-94.34437763	433
8	7189000	Elk River near Tiff City Mo	36.63146139	-94.5868886	2258
9	7188653	Big Sugar Creek near Powell MO	36.615872	-94.182222	365
10	7188885	Indian Creek near Lanagan MO	36.599275	-94.44965	619
11	7194880	Osage Creek near Cave Springs AR	36.28146623	-94.22798384	90
12	7195000	Osage Creek near Elm Springs AR	36.22202302	-94.28854149	337
13	7195430	Illinois River South of Siloam Springs AR	36.10869244	-94.53355206	1489
14	7195800	Flint Creek at Springtown AR	36.25563475	-94.43394	37
15	7195865	Sager Creek near West Siloam Springs OK	36.2017483	-94.6052206	49
16	7196900	Baron Fork at Dutch Mills AR	35.880092	-94.486606	105

B. Modeling Instructions for the Oklahoma Experiments.

B.1. Comparison of Lumped and Distributed Simulations

B.1.1 Model Run Periods

1. ‘Warm-Up’ Period: October 1, 1995 to September 30, 1996.
2. Calibration period: October 1, 1996 to September 30, 2002
3. Verification period: October 1, 2002 to September 30, 2006

Note that we will make the 2006 data available as soon as possible.

B.1.2 Time Zone and Time Step:

Participants are requested to generate simulations in Z time (GMT). Simulations should have an hourly time step or have an ordinate spacing that includes hourly values to facilitate comparison to the USGS observed hourly discharge data. The USGS hourly discharge data is supplied by HL in Z time to correspond to the time stamp of the radar precipitation data.

B.1.3 Model “Warm-Up Period”

Participants are encouraged to use the period October 1, 1995 to September 30, 1996 as a ‘warm up’ period prior to the designated calibration period. However, no adjustments to model states are allowed in this period.

B.1.4 Simulations to Submit

NOTE: Experiment for Returning DMIP 1 Participants: Hydrologic impacts of a new calibration period compared to that used in DMIP 1.

Here, we propose to assess the impacts of known biases in the archive of NEXRAD precipitation records on calibrated model results. Returning DMIP 1 participants are asked to generate the hourly discharge simulations described in the DMIP 1 modeling instructions using their calibrated models developed in DMIP 1. These simulations should use the DMIP 2 NEXRAD precipitation estimates and should span the DMIP 2 calibration and verification periods. These simulations should be easy to generate given that the DMIP 1 participants have already set-up and calibrated their models using in DMIP 1.

After that, returning DMIP 1 participants should re-calibrate their models using the DMIP 2 calibration period and data. Also, returning DMIP 1 participants should note a slight change in the DMIP 2 calibration instructions: They should also calibrate their models using the USGS gauge on the Illinois River at Siloam Springs, Arkansas instead of the USGS gauge at Watts, OK as noted below.

B.1.4.1. Illinois River Basin: Baron Fork with basin outlet at USGS gauge 07197000 at Eldon, Oklahoma. Drainage area 795 sq. km. USGS gauge on downstream left abutment of bridge on State Highway 51, 0.644km (0.4 miles) southeast of Eldon, Oklahoma. See: <http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/eldon.html> for additional basin and gauge information and site photos. Only observed streamflow data from this USGS gauge is permitted when calibrating the Baron Fork.

a. Generate 2 simulations at the basin outlet that span both the calibration and validation periods:

1. with uncalibrated/initial parameters
2. with calibrated parameters

b. While generating the 2 basin outlet simulations, compute interior simulations at:

1. Peacheater Creek at USGS gauge 07196973 at Christie, Ok., drainage area 65 sq. km (25 square miles). Gauge located 0.6436 km (0.4 miles) upstream of junction of Peacheater Creek with Baron Fork.
2. Baron Fork at USGS gauge 7196900 at Dutch Mills, Oklahoma, drainage area 105 square km. see

<http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/dutchmills.html>

NOTE: No calibration is allowed using observed streamflow data for simulations in 1 and 2 above. They are to be "blind" simulations.

B.1.4.2. Illinois River Basin: Illinois River with basin outlet at USGS gauge 7195430 South of Siloam Springs, AR. Drainage area 1,489 sq. km. (574 sq. mi.) Only observed streamflow data from this USGS gauge is permitted when calibrating models for this basin.

a. Generate 2 simulations at the basin outlet that span both the calibration and validation periods:

1. with uncalibrated/initial parameters
2. with calibrated parameters

b. While generating the 2 basin outlet simulations, compute interior simulations at:

1. Illinois River at USGS gauge 07194800 at Savoy, Arkansas. Drainage area 433 sq. km (167 sq. miles).
2. Osage Creek at USGS gauge 7194880 at Cave Springs, Arkansas. Drainage area 90 sq. km.
3. Osage Creek at USGS gauge 7195000 at Elm Springs, Arkansas. Drainage area 337 sq. km.

NOTE: No calibration is allowed using observed streamflow data in simulations 1-3. These are to be "blind" simulations.

B.1.4.3. Illinois River Basin: Illinois River with basin outlet at USGS gauge 07196500 at Tahlequah, Oklahoma. Drainage area: 2484 sq. km. Gauge 0.32 km (0.2 miles) downstream from U.S. Highway 62, 3.54 km. (2.2 miles) northeast of Tahlequah.

a. Generate 2 simulations at the basin outlet that span both the calibration and validation periods:

1. with uncalibrated/initial parameters
2. with calibrated parameters

b. While generating the 2 basin outlet simulations, compute simulations at:

1. Illinois River at USGS gauge 7195500 in Watts, OK. Drainage area 1,645 sq. km (downstream point)
2. Illinois River at USGS gauge 07194800 in Savoy, Arkansas.
3. Osage Creek at USGS gauge 7194880 at Cave Springs, Arkansas. Drainage area 90 sq. km
4. Osage Creek at USGS gauge 7195000 at Elm Springs, Arkansas. Drainage area 337 sq. km.
5. Flint Creek at USGS gauge 07196000 in Kansas, OK. Drainage area 285 sq. km (110 sq. miles). Upstream from bridge on U.S. Highway 412. See: <http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/kansas.html>
6. Flint Creek at USGS gauge 07195800 in Springtown, Arkansas. Drainage area 37 sq. km. See: <http://wmc.ar.nrcs.usda.gov/technical/HHSWR/Geomorphic/springtown.html>
7. Sager Creek near West Siloam Springs OK, USGS gauge 7195865, 49 km²
8. Illinois River South of Siloam Springs AR, USGS gauge 7195430, 1489 km²

Note: no specific calibration using observed streamflow at these points, even though calibration was performed for the Illinois River at the USGS gauge south of Siloam Springs, AR for the runs in item B.1.4.2 above.

B.1.4.4. Elk River with basin outlet at USGS gauge 07189000 in Tiff City, Missouri.

Drainage area 2258 sq. km. (872 sq. miles). Gauge located on bridge on State Highway 43, 4.83 km (3.0 miles) southeast of Tiff City.

a. Generate 2 simulations at the basin outlet that span both the calibration and validation periods:

1. with uncalibrated/initial parameters
 2. with calibrated parameters
- b. While generating the 2 basin outlet simulations, compute interior simulations at:
1. Big Sugar Creek at USGS gauge 7188653 near Powell, Missouri. Drainage area: 365 sq. km.
 2. Indian Creek at USGS gauge 7188885 near Lanagan, Missouri. Drainage area: 619 sq. km.

NOTE: No calibration is allowed using observed streamflow data in simulations 1-2. These are to be "blind" simulations.

B.1.4.5. Blue River with designated basin outlet at USGS gauge 07332500 in Blue, Oklahoma. Drainage area 1,232.3 sq. km. (476 sq. miles). Gauge location: on bridge on U.S. Highway 70, 1.6 km (1.0 mile) west of Blue, Oklahoma.

- a. Generate 2 simulations at the basin outlet that span both the calibration and validation periods:
1. with uncalibrated/initial parameters
 2. with calibrated parameters
- b. While generating the 2 basin outlet simulations, compute interior hydrographs at
1. Ungauged location on main channel of the Blue River at Lat. 34.50667, Lon. -96.675, drainage area 153.1 sq. km (59.15 sq. miles).
 2. Ungauged location on main channel of the Blue River at Lat. 34.11083, Lon. -96.625 drainage area 302.56 sq. km (116.87 sq. miles).

(note: there is no interior observed streamflow for these two points)

B.2 Modeling Instructions for the Oklahoma Mesonet Soil Moisture Experiment

B.2.1 Model Run Periods

1. Warm up period: January 1, 1996 to Dec. 31, 1996
2. Run Period: January 1, 1997 to December 31, 2002

B.2.2 Model "Warm-Up Period"

The ‘warm up’ period is allowed so that participants can let their models ‘equilibrate’. However, participants are not allowed to adjust their model states during this period.

B.2.3. Instructions

Participants are asked to set-up and run their uncalibrated models over the entire Oklahoma Mesonet domain. Models can be set up at any resolution, but must convert computed soil moisture (daily average) and runoff (*not routed cumulated water depth*) estimates to the HRAP grid scale (4x4 km). Participants are asked to generate HRAP-resolution daily grids of these two quantities. We expect to analyze soil moisture at 0-5 cm, 0-25 cm, and 25-75 cm soil layers. However, participants can generate soil moisture only for some of these layers if desired.

We propose to conduct soil moisture tests using data commonly and widely available for operational hydrologic forecasting. As such, we select the CONUS-scale STATSGO data for model parameterization. In this case, we extracted the soil texture data from the dominant class in the top 20-30 centimeters of the STATSGO data. This data set is provided on the DMIP 2 ‘Data’ web site. We require that participants use this dominant texture data set to derive their parameters for this experiment. If modelers would like to perform additional simulations using their own soil property data, they should provide HRAP grids of their soil properties.

Statistical analyses will be conducted over watershed scales and not at specific points. Comparison analyses will be performed on a soil moisture saturation ratio calculated as:

$$SR = \frac{\theta - \theta_r}{\theta_s - \theta_r}$$

where θ is volumetric water content, θ_r is residual volumetric water content (or wilting point), and θ_s is the saturation volumetric water content (or porosity).

We expect to perform two types of analyses:

- 1) Compare computed soil moisture and runoff integrated over a number of river basins (over 70 basins with drainage areas from 25 sq. km to 10,000 sq. km) to available measurements.
- 2) Compare computed daily grids (at a few levels of spatial and temporal averaging) to corresponding averages of observed data. We will examine consistency of computed and observed spatial patterns of soil moisture as well as consistency between different models. In addition, the spread between the models will be compared to differences between simulated and observed variables.

Domain window: Lat.-Lon. coordinate extents: 33.0333 to 39.35; -104.25 to -93.05
HRAP coordinate extents: rows 270 to 419; columns 419 to 650

Location of
Oklahoma

Mesonet Stations: See: http://www.nws.noaa.gov/oh/hrl/dmip/2/data_link.html

B. 3 Routing Experiments.

These experiments are designed to address science question V on page 8 of the DMIP 2 Science Plan. Here, we propose to route participants gridded runoff volumes through a common channel routing algorithm.

We propose to use a kinematic routing scheme to move water overland and through channel networks. There will be no direct use of channel cross-section measurements. Channel morphometric relationships will be defined on the 4 km HRAP grid as an analytical approximation based on channel network structure law. This approach is used in the current HL-RDHM routing scheme (Koren, et al., 2004). OHD will perform routing simulations for all participants who can provide the required input grids. Because of time constraints, this test will be performed on a relatively short time period and limited number of DMIP 2 basins.

Participants are asked to generate HRAP grids of hourly surface and subsurface runoffs as outputs from their calibrated water balance models. If some participants run their models at time and spatial resolutions different from 1-hr and HRAP scales, we ask them to perform any needed spatial-temporal averaging or interpolation. HL-RDHM performs overland routing only for the surface runoff assuming that subsurface runoff enters directly into channel. For models that do not have two runoff components, routing can be performed as only surface or subsurface runoff depending on the participant's desire. Grid file names should be as follows:

<Participant acronym><Basin acronym><grid type>MMDDYYYYTTz

where <grid type> defines information type: 'surf' for surface runoff, and 'subf' for subsurface runoff, MM, DD, YYYY are month, day and year. <Participant acronym> and <Basin acronym> and will be assigned later.

Good candidates for this test are the Blue and Tahlequah River basins. DMIP 1 experience suggests that Blue River routing may significantly affect the resultant hydrograph at the USGS gage. The Tahlequah River has a number of interior basins for tests. We selected rather short time periods which cover a number of flood events of different amplitudes:

Blue River:	from 10/10/2000 to 03/20/2001
Tahlequah River:	from 04/25/2000 to 07/31/2000.

Participants are requested to generate these simulations in Z time (GMT). Simulated grids should have an hourly time step.

B.4 Forecast Experiments: Modeling instructions coming later.